

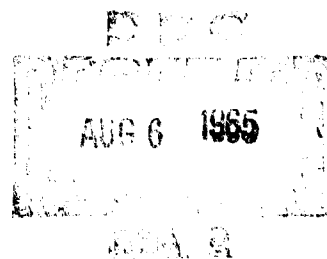
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# US ARMY TEST & EVALUATION COMMAND



DEVELOPMENT OF A METHODOLOGY FOR MEASURING INFANTRY  
PERFORMANCE IN DIGGING HASTY FIGHTING POSITIONS

SIXTH PARTIAL REPORT OF  
USATECOM PROJECT NO. 8-3-7700-01, PHASE II  
DEVELOPMENT OF METHODOLOGY FOR MEASURING  
EFFECTS OF PERSONAL CLOTHING AND EQUIPMENT  
ON COMBAT EFFECTIVENESS OF INDIVIDUAL SOLDIERS

JUNE 1965

U S ARMY  
GENERAL EQUIPMENT TEST ACTIVITY  
FORT LEE, VIRGINIA

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Development of Methodology for Measuring Effects of  
Personal Clothing and Equipment on Combat Effectiveness  
of Individual Soldiers


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## FOREWORD

This report reviews a portion of the work performed under Contract DA 19-129-QM-2068 (OI 6141) and is the sixth of a series of seven reports presenting the results of Phase II of the contract. (See Appendix C.) The project is a three-phase research effort directed toward the development of a field measurement methodology for evaluating the effects of Quartermaster clothing and protective equipment on the combat effectiveness of the individual soldier.

Earlier portions of the work accomplished under this project have indicated that a major constituent of the effectiveness of an individual infantryman in a combat situation is his level of performance in the individual physical tasks which are most important to battlefield success. A meaningful determination of the effect of clothing and personal equipment on the operating efficiency of an infantryman must therefore include objective measurements of his performance in these critical tasks. A survey of 208 highly qualified veterans of the four most recent operating theaters of the U. S. Army revealed that the ability to construct a personal fighting position rapidly in a combat area was considered to be an important physical task by combat veterans. The task usually consists of digging a man-sized foxhole quickly to provide cover from enemy fire or observation. This report describes the research performed at Fort Lee, Virginia, to establish a reliable and sensitive method for measuring performance in this activity.

The work reported represents a joint effort by Dunlap and Associates, Inc. (D&A) and the Methods Engineering Directorate of the U. S. Army General Equipment Test Activity (GETA). The project team worked together closely throughout all activities but the major effort of D&A was in the development of the measurement scheme, design of the field trials, interpretation of the data and preparation of the draft report. GETA prepared the test facilities, planned and conducted the field trials, collected and processed experimental data, and participated in its analysis.

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June 1965

ABSTRACT

A three-phase research effort is underway to develop field methodology for measuring the effects of experimental clothing and equipment on the combat effectiveness of individual infantrymen. This report covers a portion of the work performed under Contract DA 19-129-QM-2068 (OI 6141) by Dunlap and Associates, Inc., and is the sixth of a series of seven reports presenting the results of Phase II of the study.

The first partial report in this series reported work performed to identify and rank the relative importance of the physical tasks performed in combat by the individual infantryman. One of the tasks which was considered by a sample of combat veterans to be important to combat success was the ability to construct an individual fighting position rapidly in a combat area.

This report describes the work performed at Fort Lee, Virginia, to develop a reliable method for measuring soldier performance in this task. Procedures were established for measuring performance in the excavation of a simulated foxhole and tested for reliability and sensitivity to differences in clothing and equipment using USAGETA Troops. Four possible test methods were evaluated and a modified test situation with an automatic data collection system is recommended for inclusion in an integrated field course to be evaluated as the next step in the research program. The method selected involves the prestressing of participants with three 100-yard dashes after which the times to excavate specified weights of earth are recorded.

## DEVELOPMENT OF A METHODOLOGY FOR MEASURING INFANTRY PERFORMANCE IN DIGGING HASTY FIGHTING POSITIONS

### I. Review of Research Objectives

The fundamental objective of the research effort was to develop, try out and evaluate a field performance course which measures an infantry soldier's ability to dig hasty fighting positions. The three main requirements which the course had to satisfy were:

- . the test situation had to include a comprehensive sampling of those activities involved in digging a hasty fighting position;
- . the test situation had to be representative of the combat conditions under which individual infantrymen are required to perform these activities;
- . the course operating procedures, instrumentation, and measures had to yield data which were sufficiently precise to indicate that the course would be sensitive to the effects of clothing and protective equipment on performance.<sup>1, 2</sup>

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<sup>1</sup>The use of the word "sensitive" refers to the ability to detect small performance differences. A sensitive course presupposes reliability in the collection of measurement data.

<sup>2</sup>The validity of the present test situation and the performance measures to be obtained are logical (not statistical) validities. The validity of the combat task, as an important aspect of the criterion, is considered to be demonstrated by the independent judgments of combat veterans (see results from the Further Refinement of Important Combat Tasks). The validity of the test situation in which task performance is being measured must be either accepted or rejected on logical grounds. Either the test setting does or does not represent the essential features of the conditions under which a man will be required to dig hasty fighting positions. The validity of the measures must also be accepted or rejected on the basis of logic. That is, the measures either are or are not measures which reflect performance associated with digging hasty fighting positions.

Another feature, deriving in part from the foregoing, which it seemed desirable for the course to satisfy was to permit the periodic measurement of performance as the activity was sustained. The latter requirement was based on our interest in examining the trend in performance over time, as well as the total performance in this combat activity.

## II. Essentials of Test Course as Originally Proposed

The measurement situation originally proposed for research purposes was an individual test situation in which subjects would dig hasty fighting positions (unimproved foxholes) in conjunction with their performance on the March/Move Course (original squad test setting).<sup>1</sup> Initiation of the entrenching was to be signalled by the detonation of a simulated charge (or some other stimulus appropriate to a combat setting). This signal was to occur after approximately two miles and eight miles from the start of the march/move task segment, and while the troops were in a prone position off the road or trail.

Procedurally, it was planned that each squad member would be accompanied by an observer/recorder (O/R) who would, at pre-determined times and upon signal from the Senior Controller, measure the area excavated (or the amount of dirt removed). Each squad was to be accompanied by a Senior Controller who would control the initiating and halting of the entrenching according to a prepared program.

## III. Description of Actual Test Setting

The test setting originally proposed and described above was never implemented. The primary reason for this was that the squad test march/move setting was rejected before trials in the hasty fighting positions activity had been initiated. There had also been considerable concern about the comparability of data collected at different digging sites, as would have occurred under the original proposed test situation. That is, variation in soil consistency and compactness could have masked small differences in performance arising from clothing and protective equipment. The project thus moved to an individual test situation in which the digging of unimproved foxholes was evaluated using an area in which the soil had been specifically prepared

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<sup>1</sup>See Development of a Methodology for Measuring Infantry Performance in Marching and Moving. U. S. Army General Equipment Test Activity, Fort Lee, Virginia, June 1965.

for this purpose. As the following discussion will bring out, several methods were in fact tried before we arrived at what we consider a "final" test setting. As had occurred in our attempts to measure performance in marching and moving, the digging of a hasty fighting position--which had appeared to be a reasonably straightforward measurement problem--turned out to be fairly complex in the light of our concerns for measurement precision and sensitivity.

Descriptions of the test settings for the three exploratory methods and for the final method are given in the following paragraphs. Reasons for discarding each exploratory method are also given. Experimental results for all methods are discussed in the Results section.

#### A. Method 1--Loadometer Scales and Boxes

The first test concept which we evaluated was, as mentioned above, an individual test situation located in an area of open, level terrain. The piece of land itself was approximately one and one-half acres in size. In order to provide control over the consistency and compactness of the soil throughout the area, the ground was turned, disced with a cultivator and then rolled by the post engineers.

As it seemed impossible to measure with needed precision the size of the foxhole being excavated, it was decided to weigh the amount of earth removed. In addition, in early trials with Method 1, an attempt was made to correlate the number of shovel strokes with total weight excavated. Our interest was in evaluating whether or not the number of shovel strokes could be substituted for the more difficult to collect measure of amount of earth excavated.

Six, rugged, wooden boxes of dimensions 6' x 2' x 2' were constructed to serve as containers for the earth removed by each subject. The boxes each had an attached canvas apron which extended approximately 3-1/2 feet from the box. Figure 1 shows the boxes and canvas aprons. Test subjects, when told to start digging, shoveled the earth onto the apron. Every two minutes the test subject was instructed to stop digging. Two test personnel then lifted the apron causing the earth to slide into the box. The test subject was then instructed to resume digging as soon as the apron had been repositioned. The subject continued to dig until, in his judgment, he had completed a prone foxhole into which he could fit himself with no portion of his body exposed.

As shown also in the right foreground of Figure 1, a wooden frame which measured 6' x 2' was used initially to mark on the ground the size of the foxhole expected. When a subject had completed his position and the dirt had been placed in the box by means of the apron, a forklift truck took the box to a weighing station. When the weighing of the box had been completed, the forklift truck returned and emptied the box into the excavated area. The actual weighing was accomplished using an available pair of Loadometer Highway Scales. Figure 2 shows one of the boxes being weighed.

The results of our trials indicated that this first method was not satisfactory. There were two main deficiencies: 1) the scales being used to measure performance were not sufficiently precise, and they also required frequent recalibration--under the rough usage which they were receiving; 2) the lifting of the dirt into the boxes via the aprons was permitting considerably unwanted variability in the starting and stopping of subjects, and it was also permitting subjects to rest periodically--an occurrence which we felt was not representative of digging when under direct enemy fire. We thus decided to change our procedures as discussed next under "Method 2."

#### B. Method 2--Load Cell and Canvas Apron

Method 2 was again an individual test situation which used the same prepared test area. The major changes were: 1) reinforced canvas aprons measuring 6' x 4' were used exclusively to collect the dirt being excavated (in lieu of the wooden boxes); and 2) a portable load cell system, which could be suspended from the tines of the fork-lift truck, was developed to replace the Loadometer Scales. Thus, subjects dug continuously without interruption and threw their dirt onto a single canvas apron positioned to the left of the foxhole being excavated. Also, in order to provide some control over the sample of behavior to which our data referred, it was decided to require subjects to dig for seven minutes. This was the primary sample, and the amount of earth removed during this period was weighed. In order to keep subjects motivated, however, subjects knew that they would be required to continue digging beyond the seven minute period if the foxhole which they had prepared (by the end of the scheduled period) was not sufficiently large so that they could get into it with no portion of their body exposed. Figures 3 through 7 illustrate Method 2. Figure 3 shows an O/R marking out the basic dimensions of the foxhole using the aforementioned wooden frame (6' x 2'). Figure 4 shows the subject starting to dig. Figure 5 shows the foxhole near completion and the dirt piled up on the



Figure 1. Subject Digging Under Test Method 1



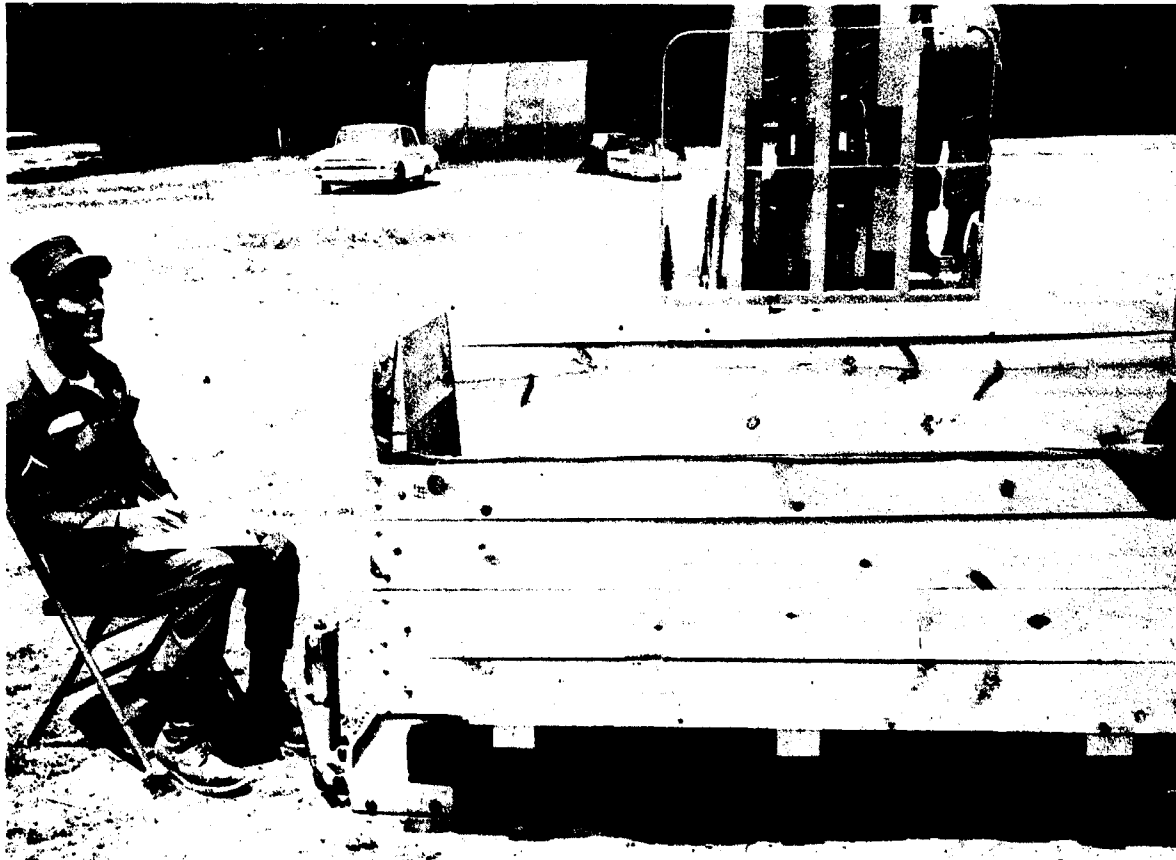


Figure 2. Measurement of Amount of Earth Excavated (Method 1)



Figure 3. O/R Marking a Digging Site (Method 2)



Figure 4. Subject Starting to Dig (Method 2)



Figure 5. Foxhole Near Completion (Method 2)



Figure 6. Foxhole Completed (Method 2)



Figure 7. Measurement of Earth Excavated (Method 2)

reinforced canvas apron. Figure 6 shows the subject in the foxhole and the O/R recording the adequacy of the hole. Figure 7 illustrates the dirt being weighed by the load cell system suspended from the tines of the fork-lift truck.

Experimental trials with Method 2 revealed that the setting and procedure, while considerably better than Method 1, might still be improved. Based upon our experiences in the other courses, we felt that possibly the latter portion (or last half) of the digging performance might be maximally sensitive to the effects of clothing and protective equipment. Also, we thought that increasing the size of sample of behavior--combined with using the latter portion of each subject's performance as our primary data sample--might appreciably increase the sensitivity of the test situation. We thus tried Method 3.

C. Method 3--Load Cell, Two Aprons, and Two Four-Minute Samples

Method 3 was similar to Method 2 except for the following changes:

- 1) Subjects were required to dig for a total of eight minutes (instead of seven minutes as in Method 2);
- 2) Two reinforced canvas aprons were used--one on either side of the foxhole being excavated;
- 3) Subjects shoveled their dirt onto one apron for the first four minutes and then onto the second apron for the second four minutes.

It was our hope that the second four minutes of performance would be maximally sensitive to the effects of clothing and equipment and could thus constitute our primary sample for analysis. As in Method 2, subjects were required to dig beyond the eight minute period if their foxhole (after eight minutes) was not adequate to permit them to take a prone position with no portion of their body exposed.

It should also be mentioned that midway through our trials with Method 3 we decided to precede the digging of the unimproved foxholes by three 100 yard dashes. Our experiences with the other courses, up to that time, had suggested that some form of prestressing (such as

might occur in the combat setting) did in some instances allow for the appearance of differences which otherwise would not have been detected using only the isolated test activity. We thus decided to require subjects to first run three 100 yard dashes and then perform the digging activity.

Figures 8 through 10 illustrate Method 3. Figure 8 shows subjects digging and using two canvas aprons onto which they threw the earth being excavated. Figure 9 shows a subject starting to throw his dirt onto the second apron--after having been told to "shift aprons" by the O/R. Figure 10 illustrates again the weighing operation.

The results with Method 3, while a seeming improvement over Method 2 results, were not totally satisfying. We simply still did not have adequate control over the size of the sample of behavior to which our data pertained. In all the other courses studied in Phase II, a standard output had been required. It was therefore decided that our attempt to control the size of the sample of behavior by use of a time limit should be abandoned. Thus, we proceeded to try still another alternative procedure.

D. Final Method--Load Cell, Box, and Two Samples at 700 and 1400 Pounds

This next (and final) method had one major change with regard to all the previous efforts. Instead of having subjects dig for a prescribed period of time, and then weighing the product of their performance, we had subjects dig specified amounts of earth. Our measure was the time required to dig the controlled amounts. We thus controlled fully the size of the sample of behavior to which the performance measures pertained.

The procedure was implemented by enlarging one of the original wooden boxes from Method 1, suspending the box from the load cell system, and requiring subjects to dig continuously (throwing their dirt into the box) until they had excavated 1400 pounds of dirt. In order to capitalize on our previous results--which did support the use of the later portions of performance as being maximally sensitive to the effects of clothing and protective equipment--we divided the 1400 pounds into two equal samples for measurement purposes. The elapsed times to dig the first 700 pounds and the second 700 pounds were recorded.





**Figure 8. Subjects Digging Under Method 3**



Figure 9. Close-Up of Subject Digging (Method 3)

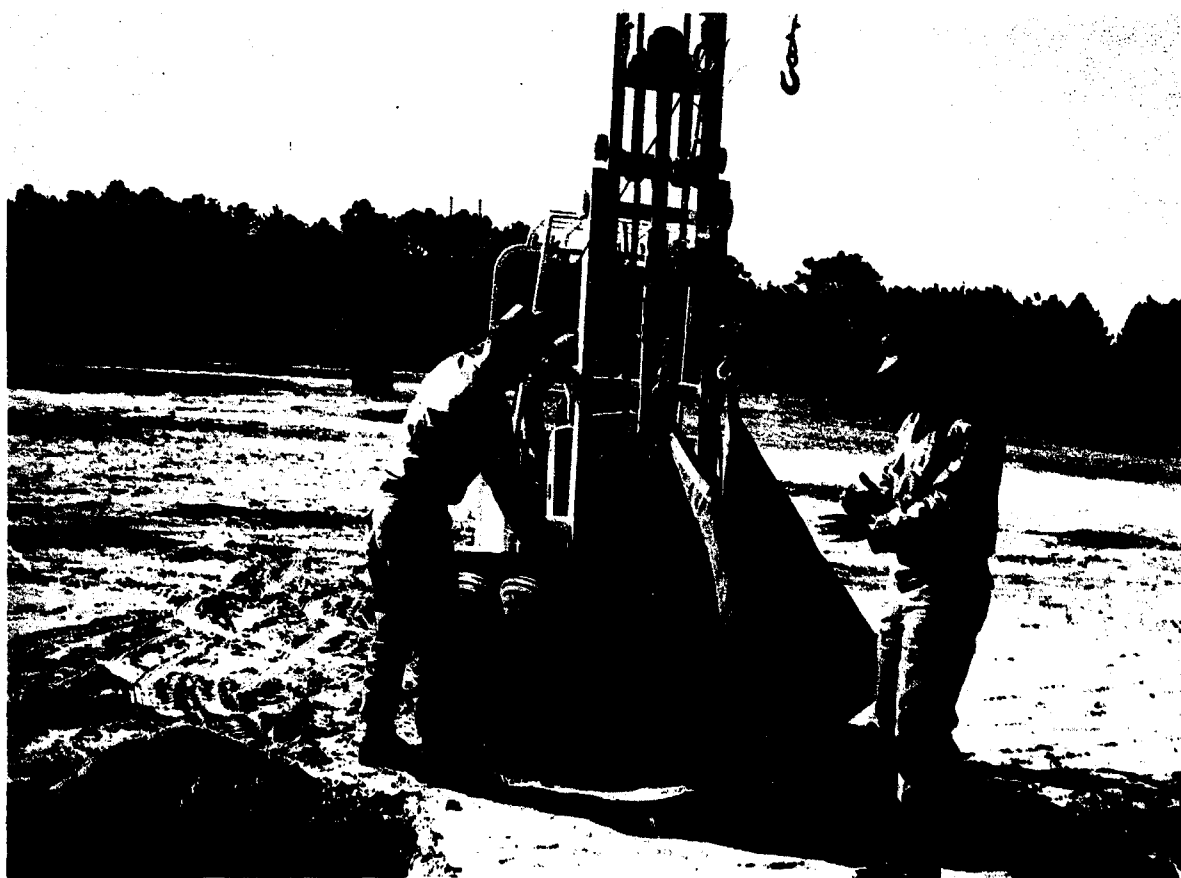


Figure 10. Measurement of Earth Excavated (Method 3)

With the exception of the procedural changes just described, this final test situation was analogous to the Method 3 test setting. It was an individual, self-paced situation using a prepared terrain. Each subject ran three 100 yard dashes before starting to dig. Figures 11 and 12 illustrate the final method. Figure 11 shows a subject, who is wearing the standard gas mask, throwing his dirt into the box. The box is suspended from the load cell system. (It should be noted that the height of the box opening is level with the surface of the terrain.) Figure 12 shows the earth being emptied from the box which had a hinged front.

#### IV. Course Operating Procedures

The preceding section, in discussing each of the test methods which were tried, has described in part the general operating procedures used with each method. This section will be limited to the procedures that applied to the final method.

Operation of the course was controlled by a Senior Controller who scheduled the starting of individuals on the three 100 yard dashes which preceded the digging. The Senior Controller was also responsible for the overall operation of the course including the assignment of O/R's, the issuance of special clothing and equipment, and the availability and checkout of the instrumentation.

Initially, on their first exposure to the courses, test subjects were read a set of standard instructions (see Appendix A). The standard instructions indicated the purpose of the course and how each subject was to proceed. After this briefing and the answering of any questions, the test subjects were started.

As already indicated, subjects were started individually on the dashes. They also performed the digging individually. The procedure was quite direct. After insuring that a subject was properly wearing the required clothing and equipment, the Senior Controller instructed the subject to take a prone position at the sandbags that marked the start of the three 100 yard dashes. When told to start by the Senior Controller, the subject ran the first 100 yard dash and took a prone position at the sandbags which marked the end of the first dash. This procedure was repeated for the next two dashes. In all cases, the delay between the completion of one dash and the start of the next was held to a minimum. (The dashes were timed, and performance data

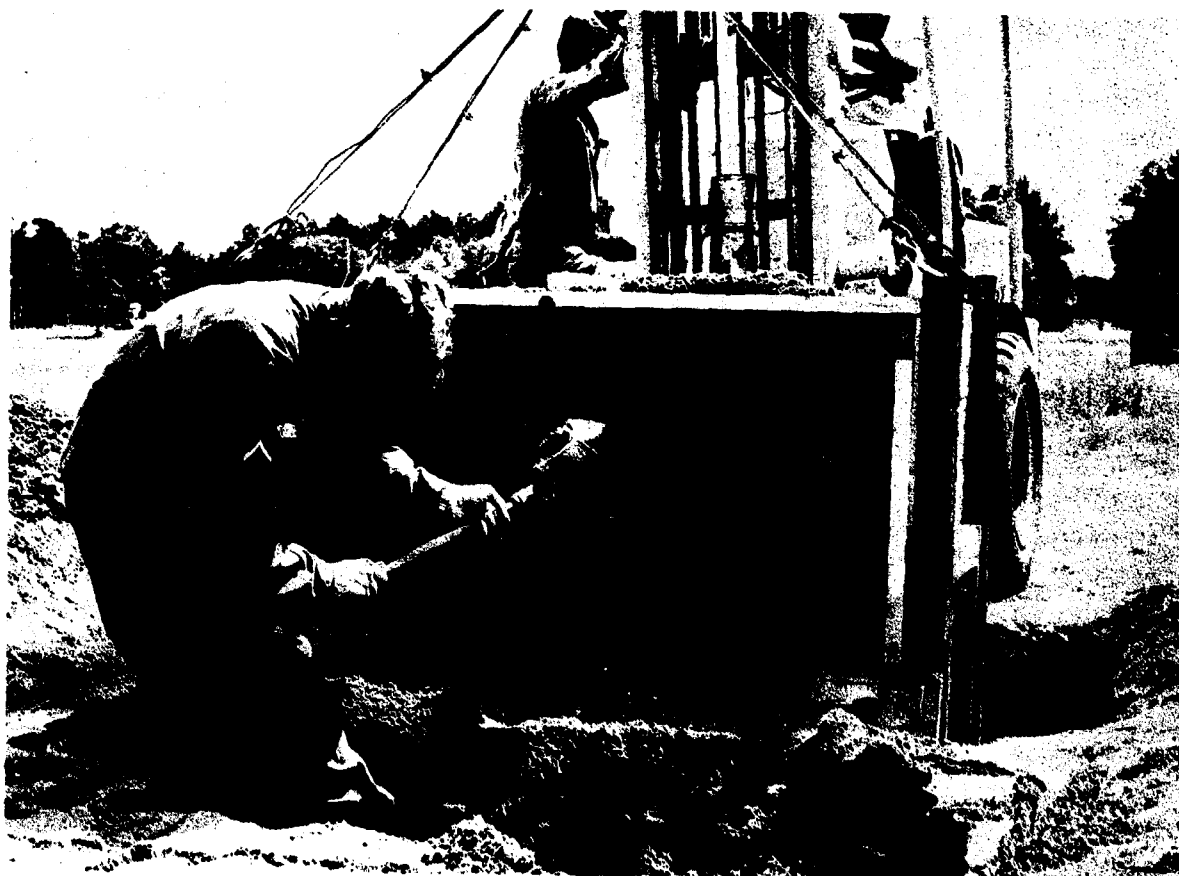


Figure 11. Subject Digging Under Final Test Method

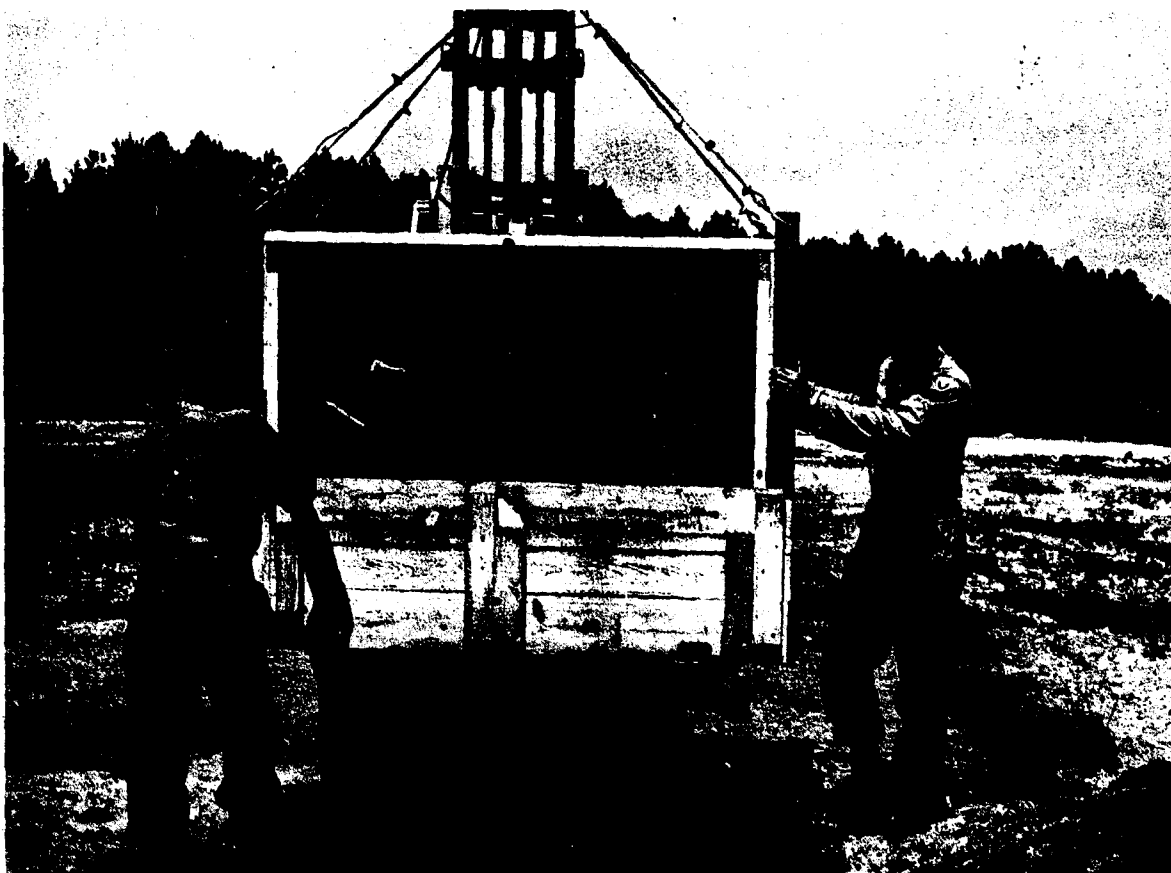


Figure 12. Emptying Wooden Box (Final Test Method)

were recorded.) When the subject reached the end of the third dash, he was directed immediately to the digging site. Thereupon, when told to start by the O/R in charge (NCOIC),\* the subject proceeded to dig a foxhole as rapidly as possible. The subject threw his dirt into the wooden box positioned parallel to the long side of the foxhole at his left. The box, which was suspended from the load cell weight measuring system, was constructed in such a fashion that the lower portion of the box could be lowered into the ground with the result that the opening of the box--into which the subject was throwing his dirt--was parallel with the surface of the ground, as shown in Figure 11. The subject thus continued to dig as rapidly as possible until told to stop. He was stopped when the load cell system indicated that 1400 pounds of earth had been excavated into the box. (Only one subject could dig at a time since there was only one load cell system to measure the amount of earth excavated.)

The duties of test personnel were also explained initially using prepared instructions. Samples of the basic O/R briefing are given in Appendix A. The duties and assignments were as follows.

The Senior Controller, as already explained, was responsible for the overall operation of the course. In particular, he started subjects on the dashes and assigned O/R's to monitor subject conduct and collect performance data.

Seven O/R's were required to support the test operation. Three were used at the 100 yard dashes which preceded the digging, and four were used at the digging site. The three O/R's on the dashes were located at the end of the dashes --one at the end of each dash. Their duties included: stopping a clock when the subject reached the end of his dash and was prone; starting simultaneously the subject on the next dash and also the time clock for the next dash; recording the time for the dash just completed; and resetting the time clock in preparation for the next subject.

The four O/R's at the digging site were assigned as follows. One simultaneously started the subject and started a stopwatch; a second monitored the load cell system and indicated when 700 and 1400 pounds of dirt had been excavated into the box; a third operated the fork-lift truck; and the fourth assisted in dumping the dirt back into the hole and rolling out the earth (using a standard, water-filled,

\*Non-Commissioned Officer in Charge.

garden-type earth roller), after the subject had completed his performance. The O/R who monitored the subject's performance and controlled the stopwatch recorded the elapsed times when the load cell system indicated 700 pounds and 1400 pounds.

#### V. Instrumentation

This section describes instrumentation used in the various methods of testing the Hasty Fighting Positions Course. Description of the Loadometer Highway Scales used in Method 1 is not included.

The instrumentation used in measuring performance consisted of: six Meylan 303D stopwatches; six hand tally registers; and a load cell weight measuring system. The load cell system was composed of: a Baldwin, Lima, Hamilton, Type U-1, 10,000# load cell; an Ellis Associates, Model BAM-1 Bridge Amplifier and Meter; a specially fabricated combination portable power supply and zero-suppression unit; a 4000 pound pneumatic tire fork-lift truck, Minn-Moline Model MB40; and a steel I-beam, assorted wire cabling and hooks to attach the load cell to the I-beam and to suspend either canvas aprons or wooden boxes from the load cell.

Figures 13, 14 and 15 show the load cell system. Figure 13 shows the bridge amplifier meter and the portable combination power supply and zero-suppression unit. Figure 14 shows the load cell attached to the I-beam and suspended from the tines of the fork-lift truck. Figure 15 shows the bridge amplifier meter and combination power supply and zero-suppression unit located at the rear of the fork-lift truck.

The zero-suppression unit was required in order to increase the precision with which weight could be read from the meter of the bridge amplifier. Our required minimum accuracy was  $\pm 10$  pounds between the range of zero through 3000 pounds. Since we had only a 10,000 pound load cell available, and since only half of the available scale length on the meter of the bridge amplifier was usable for deflections of a given polarity, the desired precision was attainable only through the entire effective scale for 1000 pound increments. Appendix B presents a schematic diagram of the weight measuring system. Also presented in the Appendix is a description of the zero-suppression unit and the results of a longitudinal test which was conditioned to determine that the entire weight measuring system was stable over the expected maximum time of operation. (Appendix B includes, in addition, a copy of the Turn-On and Calibration Procedures used with the weight measuring system.)



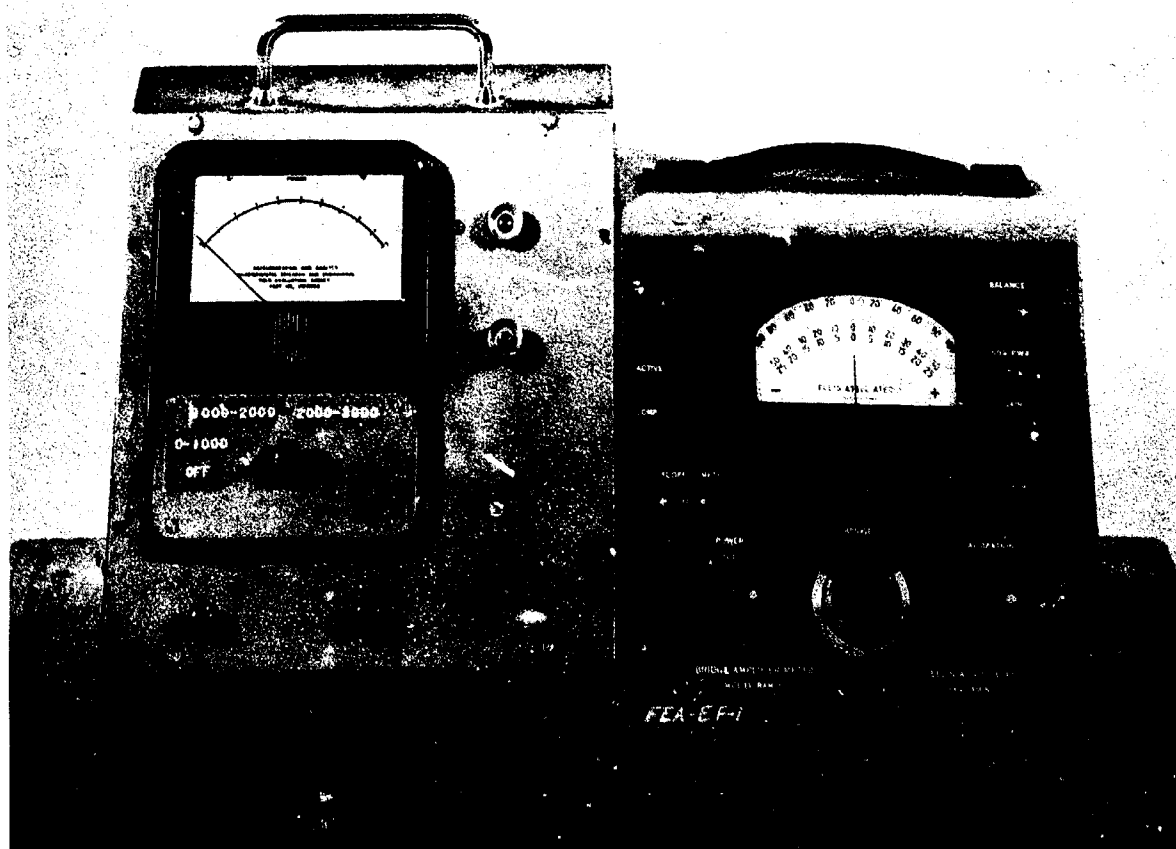


Figure 13. Instrumentation: Bridge Amplifier Meter and Combination Power Supply and Zero-Suppression Unit



Figure 14. Instrumentation: Load Cell  
Suspended from Fork-Lift Truck



**Figure 15. Instrumentation: Bridge Amplifier Meter and  
Combination Power Supply and Zero-Suppression  
Unit on Rear of Fork-Lift Truck**

The Meylan 303D stopwatches were the same as described for the March/Move Course. The stopwatch had two large hands, as shown in Figure 16. Once the watch was started, both large hands moved together and indicated elapsed time on a scale graduated with 100 marks per minute (.01 of a minute or .6 of a second). The useful feature, for our requirement, was that depression of a button on the side of the watch caused one of the large hands to stop--while the watch on the other large hand continued to accumulate time. Thus, an O/R could stop one of the hands of the watch at the instant the indicated weight of earth in the box was 700 pounds, and then read and record the time; the watch, however, was still accumulating time without interruption. Release of the side button caused the large hand which had been stopped to catch up with the moving hand. (Only one stopwatch was required in our implementation of the "Final Method." The additional watches were used in our earlier attempts to indicate when to shift canvas aprons, and to control the allowed digging time.)

Manual tally registers accumulated a count of "1" each time the operating lever was depressed. These were used in early trials with Method 1 to count the number of shovel strokes used to deliver earth into the box.

## VI. Measures and Test Design

### A. Measures

With the instrumentation described in the preceding section, data were collected on the basic measures listed below. Several other measures, derived from these basic measures, are also listed.

#### Basic Measures

- . Weight (to an accuracy of  $\pm 10$  pounds) of soil excavated (Methods 1, 2, and 3)
- . Total time (to nearest .005 minute) to excavate specific volumes of earth from a foxhole (0-700 pounds and 700-1400 pounds; Final Method)
- . Total number of shovel strokes required to excavate the soil (Method 1)



Figure 16. Meylan Type 303D Stopwatch

### Derived Measures

- . Rate of excavation (Weight/Time)
- . Average weight per shovel stroke (Total Weight/  
Number of Shovel Strokes)
- . Rate of shoveling (Number of Shovel Strokes/Time)

Reading time to .005 of a minute is probably a conservative estimate of the precision with which the watches were used. While the watches were graduated with 100 marks per minute, it was possible to interpolate between the graduations. O/R's were instructed to read time to the third decimal portion of a minute. (It should be mentioned that O/R's were also given a classroom drill both in use of the watches and in interpolating, prior to being qualified.)

### B. Test Design

The experimental testing was designed to provide information on the following points of interest:

- . The feasibility and suitability of the course concept and operating procedures;
- . The suitability of the instrumentation concept and equipment;
- . The reliability and potential sensitivity of the course.

The reliability of a given test course refers to the precision and accuracy of measurement which the course provides. It can be evaluated in terms of the consistency (i. e., repeatability) of the experimental results obtained from the course over some time period. A measure of reliability, of course, will be obtained from the Phase III testing. However, it appears possible to infer something about course reliability from Phase II results. If a statistically significant difference (at, say, the 5% level of confidence) is obtained between performance measures for a treatment condition (e. g., Gas Mask vs. No Gas Mask); one infers that the obtained difference is not likely to occur by chance. A significant performance difference suggests that, if the test were to be repeated under the same conditions (e. g., with

the same treatment conditions, the same procedures, and the same subject population), one might expect to obtain similar results. Thus one can estimate that a course is reasonably reliable if statistically significant performance differences occur. This is the best estimate that can be made on the basis of Phase II results.

The sensitivity of a test course is evaluated in terms of whether the course is able to detect a real performance difference if one exists. If a test course reveals statistically significant differences between performance measures for a treatment condition, then the course can be considered sensitive. Sensitivity and reliability of a test course are interrelated. Accurate and precise measurement will lead to a small within treatment (error) variance. The smaller the within treatment variance, the smaller are the performance differences between treatments that are needed to produce statistical significance. Thus if a test course produces statistically significant performance differences for a treatment condition, it can be assumed to be sensitive and at least minimally reliable.

The Hasty Fighting Positions Course was evaluated in repeated measurement test designs in which various weights distributed about the M56 combat pack and harness, the standard poncho, and the standard infantry gas mask (Type M17) were the independent variables or treatment conditions. The designs are illustrated in Figure 17.

The rationale underlying the use of these test designs was as follows. If the course is composed of the same activities as are required when digging a hasty fighting position in combat, and if the conditions under which these activities are performed are representative of the combat setting, then the performance data obtained from the course are a valid indication of performance to be expected under combat conditions. Thus, if one finds no significant differences among the performance measures, one might conclude that no differences will exist among the particular clothing and/or equipment items studied in the actual combat setting. It is possible, of course, that uncontrollable sources of variation may be masking small but real performance differences which will become apparent only with a more refined Phase III version of the course. However, the development of this Phase III course is better justified if it can be shown in Phase II that the course will detect real differences if they exist. It is obvious, of course, that a field performance course which fails to differentiate between the clothing and equipment which it was designed to evaluate is of little potential utility to the Army. It was our hope in selecting treatment

	15# Pack	30# Pack
Subject 1		
Subject 2		
.		
.		
Subject n		

	PONCHO	NO PONCHO
Subject 1		
Subject 2		
.		
.		
Subject n		

	GAS MASK	NO GAS MASK
Subject 1		
Subject 2		
.		
.		
Subject n		

**Figure 17. Test Designs**



conditions (the differential weights distributed about the M56 pack, the Poncho vs. No Poncho, and the Gas Mask vs. No Gas Mask) for this Phase II course that some performance differences would occur. It was also our hope in designing the measurement system that the data obtained would be sufficiently accurate and precise to detect real performance differences if they exist.

Several other points should be mentioned with regard to the foregoing test designs. First, the repeated measurements were used in order to provide sensitivity with respect to the primary independent variables. Second, in implementing the designs, the order in which subjects performed under the various treatment conditions was counterbalanced. The counterbalancing was used to offset any effects that might attend the order of testing. In implementing the counterbalancing, subjects were tested on the same day under the appropriate conditions; however, a minimum of one hour was allowed to elapse between the digging of successive foxholes. Thus, complete data were obtained from each subject on the day that the given subject appeared for testing.

## VII. Results

The data to be presented cover testing sessions which span the period of 26 November 1963 through 11 September 1964. All of the data pertain to Quartermaster test subjects. For ease of presentation, the data are broken out into four sets of results: one for each method studied.

### A. Method 1--Results

The experimental data for tests using Method 1 (Loadometer Scales and Boxes) were collected on 26 November and 5 December 1963. The treatment condition consisted of differential weights distributed about the M56 combat pack and harness. No statistically significant differences among the performance measures were obtained.

As mentioned previously, in early trials with Method 1, a count was made of the number of shovel strokes required to deliver earth into the boxes. We wished to test the degree of association between total weight and total number of shovel strokes. If close correspondence between these two performance measures could be demonstrated, we hoped to use "number of shovel strokes" to replace the more difficult to obtain measure of the amount of earth excavated.

In collecting the data on total number of shovel strokes, every shovel stroke which resulted in dirt being placed on the apron was tallied as a stroke; ground breaking strokes and chopping strokes (with the entrenching tool) were not counted.

Figure 18 presents graphically the results from 45 separate foxholes. (The men digging these foxholes were wearing one of three weighted combat packs--15 pounds, 30 pounds or 45 pounds.) The line drawn through the data in Figure 18 is the least squares regression line (for predicting weight from strokes). The product-moment correlation coefficient between the two measures was  $r = .43$ . Thus, as shown by the magnitude of the correlation coefficient and the scatter plot in Figure 18, we concluded that the degree of association between the two measures was not sufficient to encourage us that "number of shovel strokes" could be substituted for total weight. We subsequently stopped collecting data on the number of shovel strokes.

#### B. Method 2--Results

The experimental data from tests using Method 2 (Load Cell, Canvas Aprons, Seven Minute Primary Sample of Behavior) were collected on 13 and 16 March 1964. Table 1 presents the results obtained under the Gas Mask versus No Gas Mask conditions. Presented in Table 1 are the size of the sample, the average performance under each of the two conditions on each date, and the results of a statistical test for differences between conditions. In making the statistical test, a one-tailed t-test using the differences between the related data from each subject was used.<sup>1</sup> The one-tailed test is the proper one under our hypothesis that, if a difference occurred, it would be in the direction of a decrease in performance with the gas mask.

As may be seen in Table 1, a significant performance difference occurred on the first date but not on the second. On both dates, subjects dug more earth without the gas mask than with the gas mask.

While these results were favorable, we thought it possible to improve the sensitivity of the test event by: 1) looking at the latter

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<sup>1</sup>See Walker, Helen M. & Lev, J. Statistical Inference, Holt, New York, 1953, pp. 151-154 concerning the mean of a population of differences between two measures for each subject.

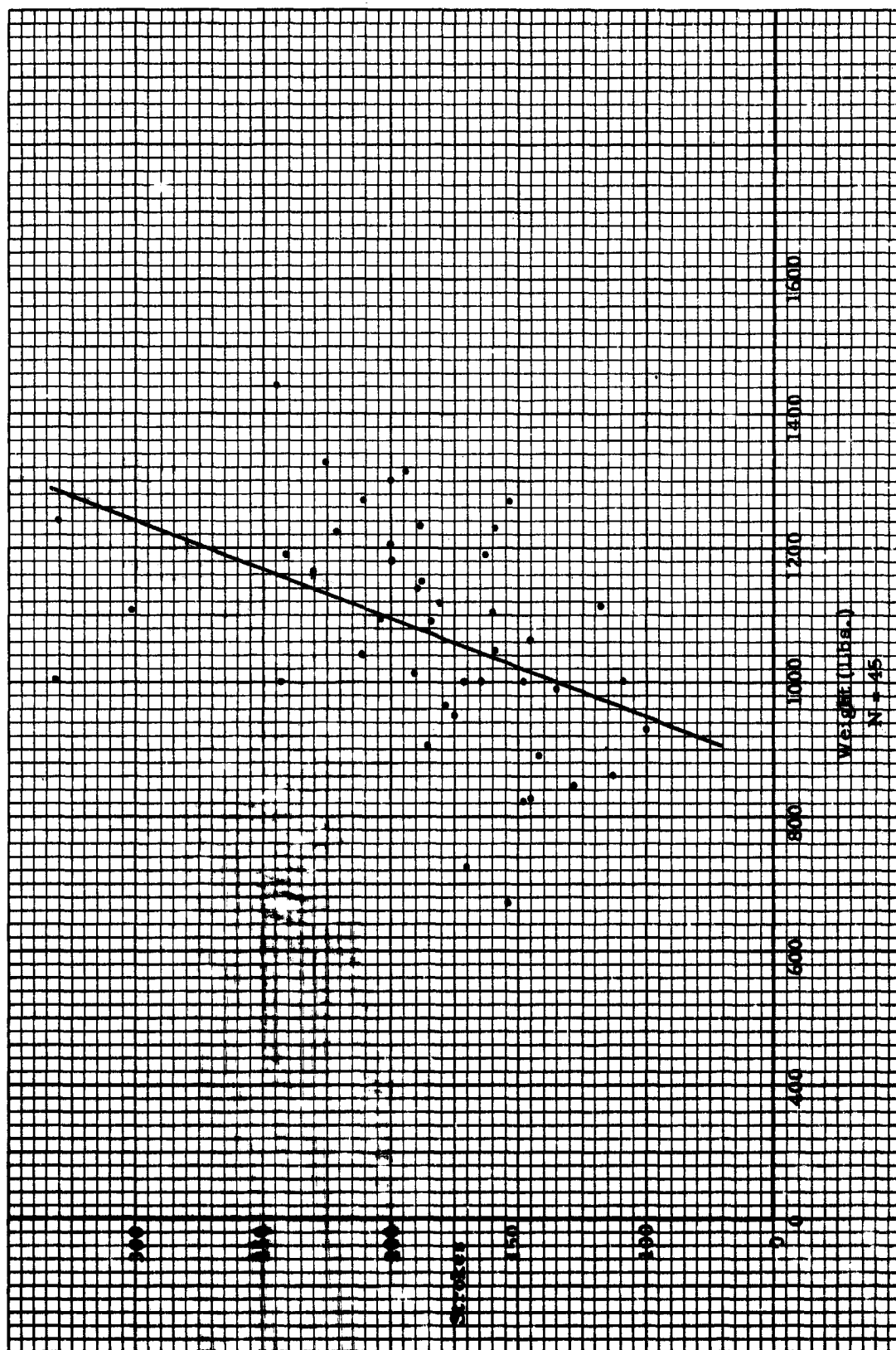


Figure 18. Association of Total Weight and Number of Shovel Strokes

portion of performance as our primary sample of data; and 2) increasing the total sample of behavior to eight minutes.

Table 1. Comparison of Gas Mask versus  
No Gas Mask using Method 2

Date of Trial	Average Performance (pounds)		Significance of Difference
	With Mask	Without Mask	
13 March	675	814	*
16 March	747	771	N. S.

Total of 7 Minutes Digging (N = 9, Each man dug  
with and without mask on each date)

\* Statistically Significant Difference  $p < .05$

#### C. Method 3--Results

The experimental data from tests using Method 3 (Load Cell, Two Aprons, Two Four-Minute Samples) were collected on 23 March, 17 April and 18 May 1964. All of the data pertain to Quartermaster test subjects. Tables 2, 3, and 4 present the results from comparisons of: the 15-pound combat pack versus the 45-pound combat pack; with the poncho versus without the poncho; and additional comparisons with the gas mask and without the gas mask. Presented in each table are the size of the sample, the average performance under the indicated conditions, and the results of statistical tests for the significance of the obtained differences. The statistical test used was a one-tailed t-test for differences between repeated measures on the same subjects. Our hypothesis was that performance would be degraded with the heavier packs, with the mask, and with the poncho.

As shown in Table 2, a significant performance difference in the expected direction occurred between the 15-pound pack versus the 45-pound pack. Furthermore, as revealed by separate statistical tests of the two four-minute periods, it was the latter portion of performance (the second four-minute period) which was maximally sensitive to the treatment conditions. Thus, men dug a greater weight of earth with the

Table 2. Comparison of Weighted Combat Packs  
and Poncho versus No Poncho Using Method 3

Data of 23 March 1964; N = 10

Men Digging for 8-Minutes Total, Divided into Two 4-Minute Periods

Time Periods	Average Performance (lbs.)		Significance of Differences
	15# Pack	45# Pack	
1st 4-Minute Period	718.0	656.5	N.S.
2nd 4-Minute Period	497.0	412.5	*
Total 8 Minutes	1215.0	1069.0	*

Time Periods	Average Performance (lbs.)		Significance of Differences
	Poncho	No Poncho	
1st 4-Minute Period	684.5	691.0	N.S.
2nd 4-Minute Period	500.0	540.5	N.S.
Total 8 Minutes	1184.5	1231.5	N.S.

\* = Statistically Significant Differences,  $p < .05$

Table 3. Comparison of Gas Mask versus No Gas Mask  
Using Method 3

Data of 17 April 1964; N = 11

Men Digging for 8-Minutes Total, Divided into Two 4-Minute Periods

Time Periods	Average Performance (lbs.)		Significance of Differences
	Mask	No Mask	
1st 4-Minute Period	729.5	767.7	N. S.
2nd 4-Minute Period	475.0	432.3	N. S.
Total 8 Minutes	1204.5	1200.0	N. S.

**Table 4. Additional Comparison of Gas Mask versus  
No Gas Mask Using Method 3**

Data of 18 May 1964; N = 10

Subjects Ran Three 100-Yard Dashes Wearing the "A" Pack (and with or without the Gas Mask) Before Digging. Note: Men Dothed the Pack Before Digging.

Course Event	Average Performance (Sec.)		Significance of Differences
	Mask	No Mask	
1st 100-Yard Dash	21.36	20.14	N. S.
2nd 100-Yard Dash	24.18	22.55	*
3rd 100-Yard Dash	24.20	21.32	**

Time Periods	Average Performance (lbs.)		Significance of Differences
	Mask	No Mask	
1st 4-Minute Digging Period	537.5	489.0	N. S.
2nd 4-Minute Digging Period	441.0	383.0	N. S.
Total 8 Minutes	978.5	872.0	N. S.

\* = Statistically Significant Differences,  $p < .05$

\*\* = Statistically Significant Differences,  $p < .01$

lighter combat pack (the 15-pound pack), and the performance difference between the two packs was greater in the second four minutes of the total eight minutes of performance.

As shown also in Table 2, no significant performance difference was detected between the Poncho versus No Poncho condition.

Table 3 presents the results from a comparison of the Gas Mask versus No Gas Mask condition (using Method 3). No significant performance differences were detected. At this point, we decided (as mentioned earlier) to introduce three 100 yard dashes as a prestressor before the foxhole digging.

With the three dashes preceding the foxhole digging, we replicated the Gas Mask versus No Gas Mask test. The results for both the three 100 yard dashes and for the digging are shown in Table 4. With regard to the dash events, significant performance differences in the expected direction were obtained. The results with the digging activity were a further surprise. Average performance measures in all cases favored the Mask condition.

As a result of the Method 3 tests, we felt that use of a time limit for the digging activity provided inadequate control over the size of the sample of behavior. We then moved to the "Final Method" in an effort to control better the size of the sample to which our performance measures pertained.

#### D. Final Method--Results

The experimental data from the tests using the Final Method (Load Cell, Box, Two Samples at 700 and 1400 Pounds) were collected on 10 and 11 September 1964. The results both for the three 100 yard dashes and for the digging activity are presented in Table 5. Since the weight of the earth to be dug by each subject was now held constant, the performance measure (in the digging) was the elapsed time to excavate the specified amount of earth. Shown in the table are the size of the sample, the average performance under the indicated conditions, and the results of one-tailed t-tests for the significance of differences between conditions.

As shown in Table 5, significant performance differences in the expected direction were obtained. Subjects again ran the dashes faster without the Gas Mask than with the Gas Mask. With regard to



**Table 5. Comparison of Gas Mask versus No Gas Mask  
Using Final Method**

Data of 10-11 September 1964; N = 11

Subjects Ran Three 100-Yard Dashes Wearing the "A" Pack (and with or without the Gas Mask) Before Digging. Note: Men Doxed the Pack Before Digging.

Course Event	Average Performance (Secs.)		Significance of Differences
	Mask	No Mask	
1st 100-Yard Dash	23.89	21.34	*
2nd 100-Yard Dash	26.14	23.70	*
3rd 100-Yard Dash	25.16	22.14	**

Samples	Average Performance (Mins.)		Significance of Differences
	Mask	No Mask	
1st 700 Pounds	2.81	2.47	*
2nd 700 Pounds	3.63	3.04	**

\* = Statistically Significant Differences,  $p < .05$

\*\* = Statistically Significant Differences,  $p < .01$

our primary interest--the digging--subjects dug the required samples significantly faster without the Gas Mask. Furthermore, the difference in performance for the latter portion of performance (700-1400 pounds--or second 700-pound sample) was the more sensitive segment of the total performance.

#### VIII. Interpretation of Results

The following conclusions are made in reference to the results presented in the preceding section:

- . The magnitude of the differences detected as significant with the weighted combat packs and under the Gas Mask versus No Gas Mask conditions are interpreted to indicate that the Final Method of the Hasty Fighting Positions Course is sensitive and will differentiate among clothing and protective equipment to a practically useful extent.
- . The results obtained using the Final Method (i. e., requiring subjects to dig fixed weights of earth and using elapsed time as the dependent measure of performance), especially in the light of the results obtained with the earlier methods, are interpreted to indicate that this is the preferred way to measure performance in this combat activity.
- . The results obtained from the comparison of the weighted combat packs using Method 3 and from the comparison of Gas Masks versus No Gas Masks using the Final Method substantiate using the latter portion of performance as the primary sample for analysis purposes. The latter portion of performance in this combat activity will be maximally sensitive to the effects of clothing and protective equipment.

#### IX. Recommendations for Final Test Course

Based upon all of the experiences gained in the tryout of the Phase II courses, the following recommendations have merit for the design and operation of the Phase III Hasty Fighting Positions Course.

- . It is recommended that the Final Method described in this report be used as the basis for designing the Phase III course. Subjects should be required to dig specific amounts of soil, and the primary dependent measure should be elapsed time.

- . The instrumentation used in the Phase III course should be better suited to the range of expected measurements. Two thousand pound load cells should be used. The meters displaying weight should present the entire range of expected values using the total available scale to represent this range. (It should not be necessary to change scales or use a zero-suppression unit to cover the limited range which is needed.)
- . If further research is possible, it would seem desirable to investigate the sensitivity of a situation where subjects dig a total weight of 1500 pounds divided into three subsamples of 500 pounds each. The individual segments could be evaluated and then any indicated combination of segments accomplished.
- . Consideration should be given to automating the data collection. If, for example, the primary sample of data is to be the second 700 pounds, it should be relatively easy to cause a timing device to "start" when the deflection of the weight-indicating meter reaches 700. The clock could be stopped (and the elapsed time printed, or recorded) automatically when the weight-indicating meter reaches 1400 pounds.

**APPENDIX A**

**Final Method**

**O/R Briefing  
Troop Briefing**

A-1

HASTY FIGHTING POSITIONS COURSE  
O/R BRIEFING - FINAL METHOD

I. Purpose of the Course

The purpose of the Hasty Fighting Positions (HFP) course is to study the effects of Quartermaster clothing and protective equipment on the infantry soldier's ability to rapidly dig a foxhole. This course, like the March/Move course, is one of a series of courses being developed to measure performance in the most important combat tasks of line infantry.

In this HFP course, and as will be discussed more fully in a moment, we are primarily interested in how long it takes the soldier to remove a specified amount of earth from the ground.

II. Course Description

The present course is a preliminary one and consists of three 100-yard dashes plus a digging area.

In order to assure consistent digging conditions we are utilizing sand which has been water soaked and rolled prior to the digging sessions.

Participants will dig until they have transferred 1400 pounds of sand from the digging area into the weighing box located adjacent to the digging area. The weighing box will be suspended upon a load cell which is attached to a forklift, thereby allowing for continuous weighing operations.

III. Observer/Recorder Procedures

Participants will perform on the course individually. Basic uniform will be fatigue jacket and trousers, combat boots and fatigue hat. Special clothing or equipment may be issued by the Senior Controller prior to the participant running the course.

An Observer/Recorder will be located at the end of each 100-yard dash. The NCOIC will serve as starter at the initial 100-yard dash. After checking with the O/R stationed at the finish of the first 100-yard dash to insure his clock timer is working properly, he will tell the participant to "START." After the participant has reached the prone

position at the end of the dash and has the weapon to his shoulder, the O/R will stop the clock timer, record the time (to nearest .01 second) the participant required to complete the dash, and at the same time start his stop watch. At the end of 1 minute the O/R will start the participant on the next dash. This procedure will be repeated until the participant has completed the three 100-yard dashes.

After the third dash the participants will complete the digging portion of the course. The digging area consists of prepared sand located in a pit. Adjacent to the sandpit is located a weighing box suspended from a load cell device. When told to start, participants shovel sand from the pit into the weighing box as rapidly as possible until told to stop. (Participant will be stopped when he has transferred 1400 pounds of sand from the pit into the box.) The weight indicator is monitored continuously and data recorded as to the amount of time (to nearest .005 min.) it takes the participant to shovel the first 700 pounds of sand and the time to shovel a total of 1400 pounds of sand.

#### IV. Preliminary Procedures

Prior to the start of each test run, O/R's should:

- a. Check to be sure that their clock timers and stop watches are reset and in proper working order.
- b. Inspect the test participant to be sure that he is in proper uniform and properly wearing the experimental equipment on which he is being tested.

#### V. Observer/Recorder Data Form

Describe and go over form with the Observer and answer any questions.

## HASTY FIGHTING POSITIONS COURSE

### TROOP BRIEFING - FINAL METHOD

#### I. Purpose of the Course

You are serving in research experiments that will eventually lead to a standard course on which to evaluate the effects of Quartermaster clothing and equipment on a soldier's ability to perform important combat tasks. This is a serious and expensive undertaking. Everyone wants the American soldier to have the best clothing and equipment. The best clothing and equipment may save lives.

Today, and for the next few days, we will be evaluating our preliminary concepts for a course designed to reveal the effects of Quartermaster clothing and equipment on the infantry soldier's ability to dig an unimproved, hasty fighting position.

#### II. Course Procedures

The course upon which you are about to participate is the Hasty Fighting Positions Course of the Combat Effectiveness Methodology Study. The course consists of three 100-yard dashes followed by a digging task. Participants will wear the standard fatigue uniform, load carrying equipment, M-1 rifle, and whatever special clothing and equipment is issued by the Starter/NCOIC. You will first run the three 100-yard dashes in consecutive order. You will be started by the NCOIC on the first dash and are to complete the dash as quickly as possible. When you reach the sandbag position, assume a prone position with your weapon at your shoulder. Remain in this position until the O/R located there tells you to start the second dash. Repeat this procedure for all three dashes. Remember that we are interested in how quickly you can complete these dashes.

After completing the third dash you will participate in the digging area. Your task will be to transfer the sand from the sand pit into the box located immediately adjacent to the pit. Work as rapidly as possible and continue to transfer the sand into the box until told to stop. We are interested in how long it takes you to transfer a specified amount of sand.

This entire procedure will be repeated after a one-hour rest period.

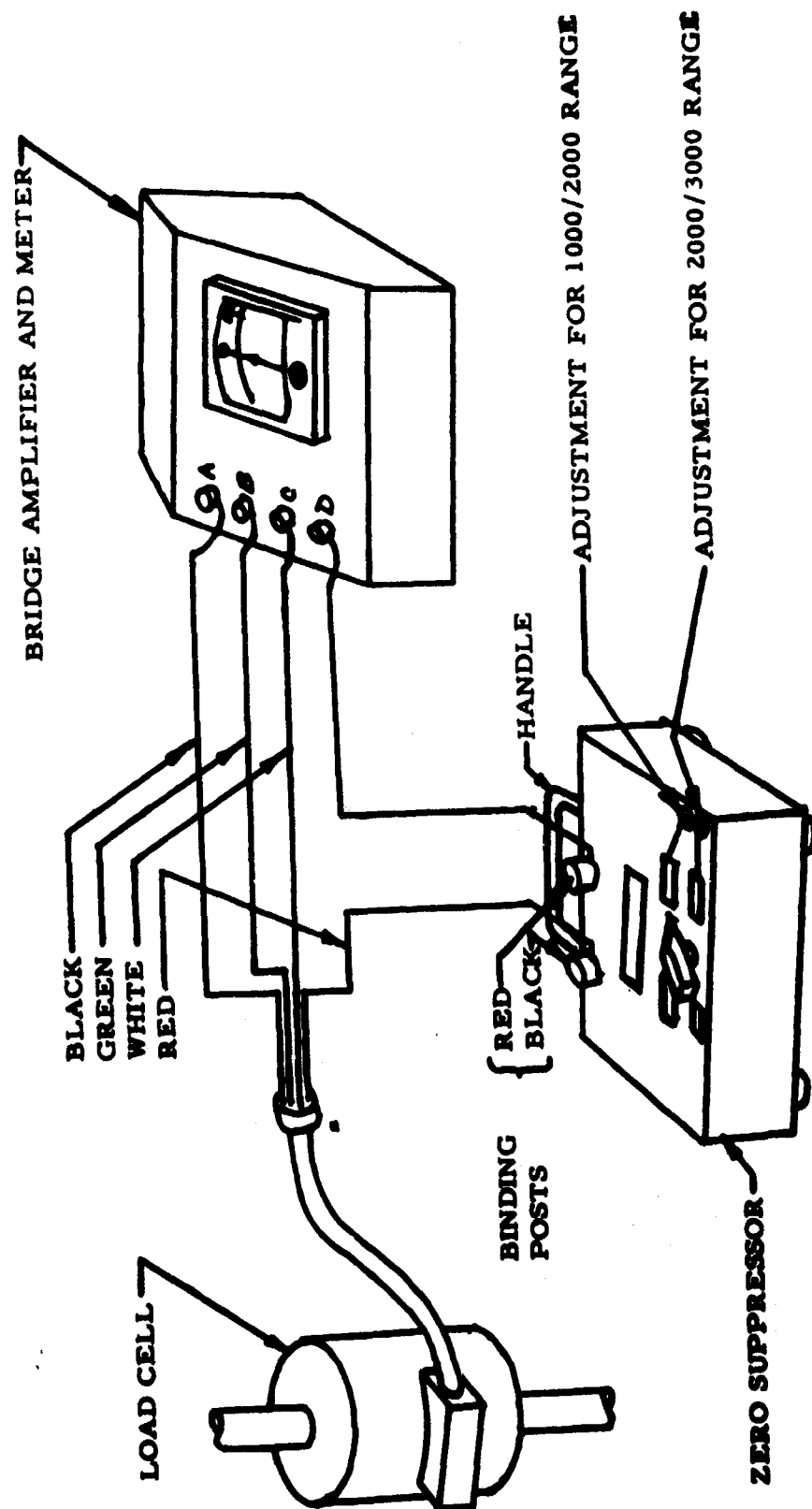
Are there any questions?

## APPENDIX B

- . Schematic Diagram of Weight Measuring System
- . Results of Longitudinal Test for Stability of Weight Measuring System
- . Description of Zero-Suppression Unit
- . Turn-On and Calibration Procedures for Weight Measuring System

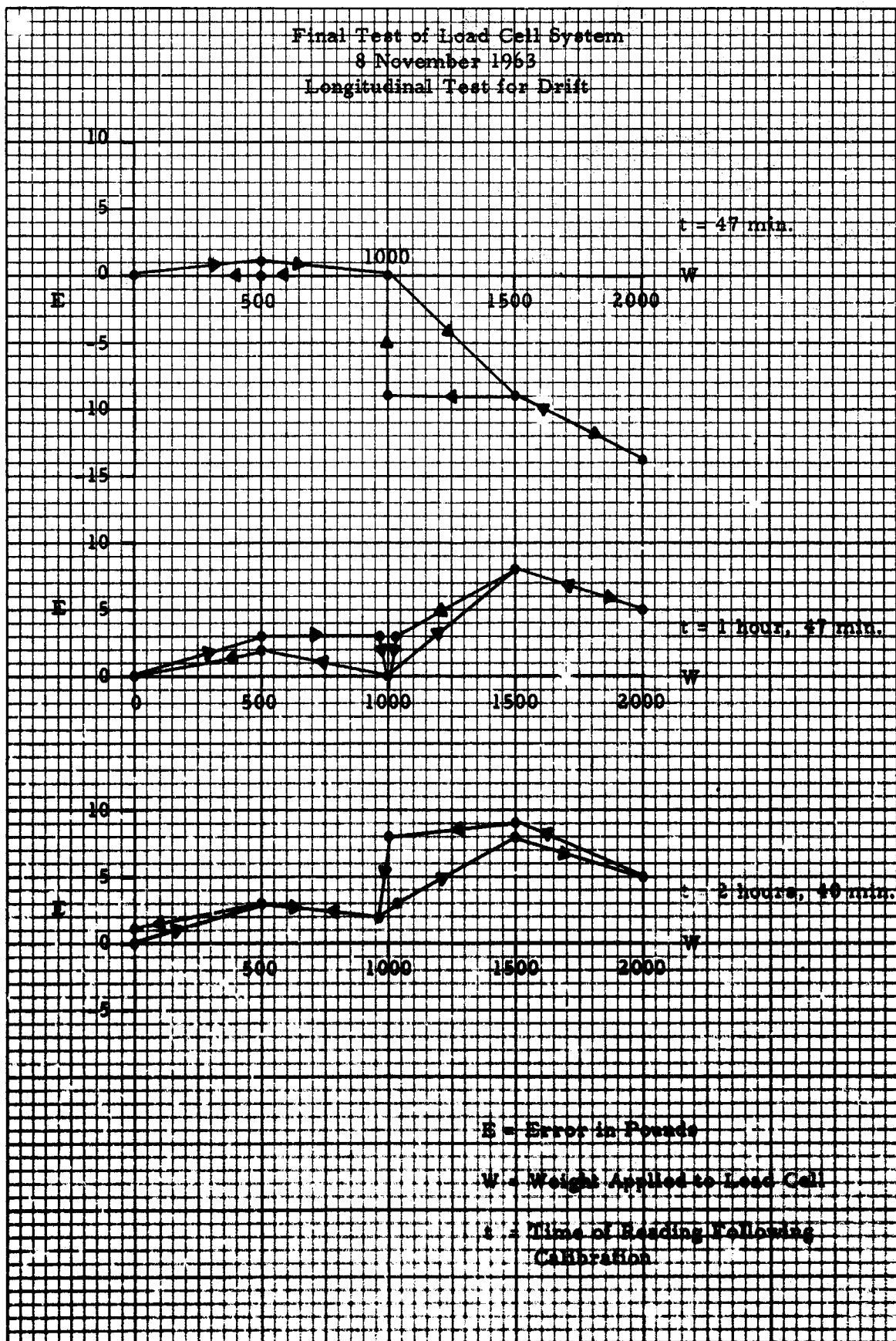


B-1



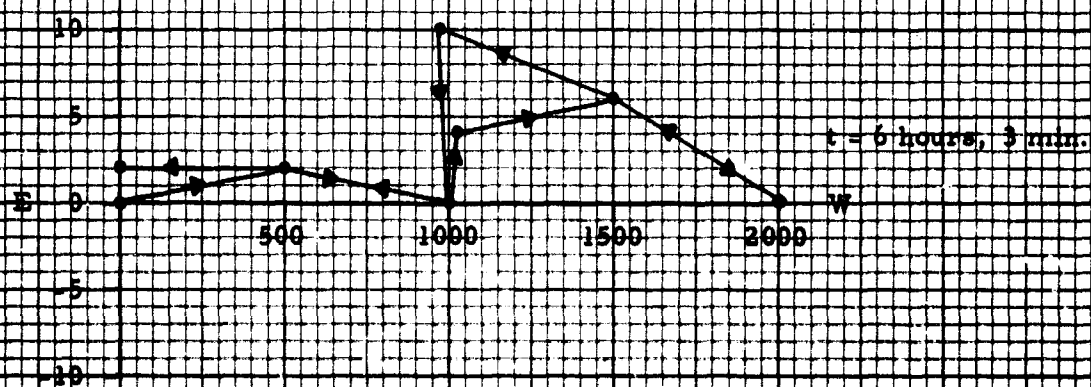
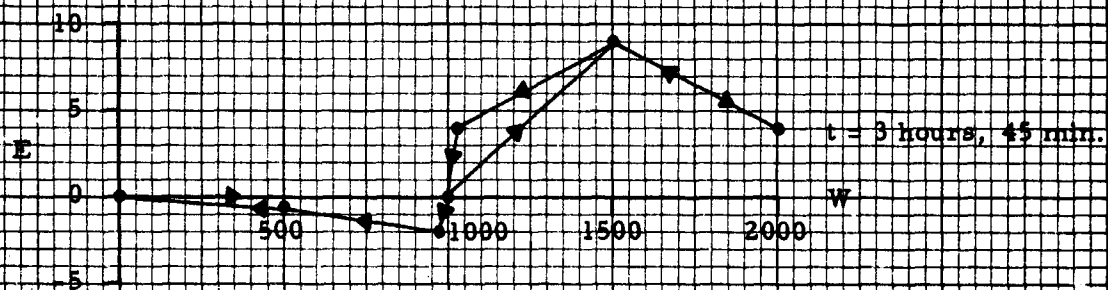
Schematic Diagram of Weight/Measuring System

Final Test of Load Cell System  
8 November 1963  
Longitudinal Test for Drift



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Final Test of Load Cell System  
8 November 1963  
Longitudinal Test for Drift



E = Error in Pounds

W = Weight Applied to Load Cell

t = Time of Reading Following Calibration

## DESCRIPTION OF ZERO-SUPPRESSION UNIT

### I. Purpose

The purpose of the Zero Suppressor is to provide a stable source of voltage which may be added in series opposition with the output voltage from the Load Cell (SR-4) so that scale ranges of 0/1000, 1000/2000, and 2000/3000 pounds may be obtained on the Bridge Amplifier and Meter (BAM-1).

### II. Connecting the Zero Suppressor

The discussion refers to the schematic diagram shown in page 46. The interconnections shown should result in an up-scale reading (i. e., pointer on meter will deflect to the right) for an applied tensile load.

The recommended procedure for connecting the Zero Suppressor is as follows:

- a. Connect the Load Cell to the Bridge Amplifier and Meter in the usual manner.
- b. Calibrate the measuring system in the usual manner.
- c. Apply a load of 1000 pounds to the Load Cell.
- d. Connect the Zero Suppressor into the wire lead connected to the binding post marked "D" on the Bridge Amplifier and Meter chassis. (See page 46)
- e. Turn the Zero Suppressor on by rotating the selector switch (on the Zero Suppressor chassis) to the "1K/2K" position. (Be certain to center the selector switch properly on the detent corresponding to the "1K/2K" position.)
- f. If turning on the Zero Suppressor causes the meter reading (on the Bridge Amplifier and Meter chassis) to decrease, then the Zero Suppressor has been properly connected. If

the meter reading increases when the Zero Suppressor is turned on (in Step e., above), then the two wires connected to the binding posts on the Zero Suppressor must be interchanged.

The next step will be to calibrate the Zero Suppressor.

### III. Calibration of Zero Suppressor

The Zero Suppressor has two ranges which must be calibrated. Due to the characteristics of the Bridge Amplifier and Meter instrument, a calibration will be necessary each time the system is to be used.

The recommended procedure for calibrating the Zero Suppressor is as follows:

- a. Connect the Zero Suppressor to the weight/measuring system by following the procedure outlined in Section II above.
- b. With the Zero Suppressor switch in the "OFF" position, calibrate the Bridge Amplifier and Meter and the Load Cell in the usual manner. Allow the Load Cell and the Bridge Amplifier and Meter about 15 minutes of operation to stabilize before attempting to calibrate them. Adjust the calibration so that an applied load of 1000 pounds will deflect the meter pointer from 0 to 100, i. e., a full-scale deflection to the right from the center (zero) position.
- c. With the Load Cell and Bridge Amplifier and Meter calibrated, apply a 1000 pound load to the Load Cell.
- d. Turn the selector switch on the Zero Suppressor to the "1000/2000" position and allow several minutes for the Zero Suppressor to stabilize (i. e., to reach thermal equilibrium). The meter reading on the Bridge Amplifier and Meter should decrease as soon as the Zero Suppressor is turned on. (If the meter reading increases, the Zero Suppressor has been improperly connected. Reconnect the Zero Suppressor according to the recommended procedure under Section II above.

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- e. The Zero Suppressor may be calibrated (after turning it on for several minutes to allow it to stabilize) on the "1000/2000" range by rotating (by means of a small screwdriver) the appropriate adjusting screw (in the lower right-hand corner of the Zero Suppressor chassis--see Figure 13) until the meter pointer on the Bridge Amplifier and Meter reads zero (i. e., is positioned back to the center of the scale). The trimmer potentiometer adjusting screw can be rotated for a total of 25 turns. Turning the adjusting screw beyond its limits will result in a clicking sound for each revolution. (The clicking sound emanates from a protective ratchet-device built into the trimmer potentiometer.)

NOTE: The range over which the Zero Suppressor can be calibrated was designed on the basis of nominal values of amplifier gain and Load Cell supply voltage. It is possible that the adjustment range of the Zero Suppressor may be insufficient to allow the return of the meter pointer to the center position. In this case, the Bridge Amplifier and Meter instrument will require some minor modifications (at which time the system can be modified to utilize the complete meter scale instead of only half).

Assuming that the adjustment range is adequate and that the steps just described have been carried out, the weight/measuring system can now be used to measure any weight between 1000 pounds (for which the meter pointer will be at the center of the scale, i. e., at zero) and 2000 pounds (for which the meter pointer will deflect to the right-hand side of the scale to a reading of 100). A weight of 1500 pounds would, for example, cause the meter pointer to deflect to a position halfway between the center and the right-hand side of the scale.

- f. To calibrate the system to measure between 2000 pounds and 3000 pounds, first apply a weight of 2000 pounds to the Load Cell. Turn the Zero Suppressor selector switch to the "2000/3000" position and rotate (by means of a small screwdriver) the appropriate adjusting screw (in the lower right-hand corner of the Zero Suppressor

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chassis) until the meter pointer reads zero (i. e., is positioned back to the center of the scale).

The weight/measuring system can now be used to measure any weight between 2000 pounds (for which the meter pointer will indicate zero) and 3000 pounds (for which the meter pointer will deflect to the right-hand side of the scale to a reading of 100). The scale will be linear between 0 and 100; for example, a weight of 2750 pounds will cause the meter to give a reading of 75 (i. e., the meter pointer will deflect up-scale to a point 75% of full-scale).

**TURN-ON AND CALIBRATION PROCEDURE  
FOR WEIGHT MEASURING SYSTEM**

- I. Allow Ellis Amplifier-Bridge to warm up for 15 minutes with "BDG-PWR" switch in the "PWR" position.
- II. Calibrate Ellis Unit as follows:
  - a. Connect Zero Suppression Unit.
  - b. Attach and suspend empty canvas cables.
  - c. Put Zero Suppression Unit on "0-1000#" position.
  - d. Adjust balance with "BDG-PWR" switch on "BDG" so that meter reads "0" -- center scale. Return "BDG-PWR" switch to "PWR" position.
  - e. Set calibration switch to "x5".
  - f. Using bridge control and gain control, adjust meter so that:
    - 1) the meter reads 51.5 when the calibration button is depressed;
    - 2) the meter reads "0" -- full left scale when the calibration button is not depressed.
  - g. Recheck balance adjustment... (Repeat step d. if necessary)
- III. Put 1000# true weight in canvas and pick-up.
- IV. Check that meter reads 1000#--(if not, unload canvas and repeat steps a. to g.
- V. Put Zero Suppression Unit on "1000/2000#" position--meter should read "0" -- full left scale. (If not, adjust potentiometer on Zero Suppression Unit to give a reading of "0" with 1000# true weight on the canvas.)



**APPENDIX C**  
**Project Reports**

**PROJECT REPORTS**

- I. Report of Phase I, USATECOM Project No. 8-3-7700-01, Development of a Methodology for Measuring Effects of Personal Clothing and Equipment on Combat Effectiveness of the Individual Field Soldier, U.S. Army QM R&E Field Evaluation Agency (now U.S. Army General Equipment Test Activity), February 1964.
- II. Reports of Phase II, USATECOM Project No. 8-3-7700-01, Development of Methodology for Measuring Effects of Personal Clothing and Equipment on Combat Effectiveness of Individual Soldiers, (U.S. Army General Equipment Test Activity):
  1. Identification of Important Tasks of Combat Infantry - Report of Results from a Further Refinement, November 1964.
  2. Development of a Methodology for Measuring Infantry Performance in Rifle Firing and Reloading, June 1965.
  3. Development of a Methodology for Measuring Infantry Performance in Maneuverability, June 1965.
  4. Development of a Methodology for Measuring Infantry Performance in Marching and Moving, June 1965.
  5. Development of a Methodology for Measuring Infantry Performance in Grenade Throwing, June 1965.
  6. Development of a Methodology for Measuring Infantry Performance in Digging Hasty Fighting Positions, June 1965.
  7. Final Report, Phase II, December 1964.



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